Chemistry
Grades 9-12

Strand:

S8 Chemistry: The student demonstrates a conceptual understanding of the organization and behavior of matter; that is, the student:

Standard: S8a: Communicates an understanding of atomic structure, addressing parts and properties of the atom.

Components:

S8a1 Describes matter (e.g., chemical substances, common materials, living organisms) as being made of enormous numbers of minute particles called atoms (e.g., by referring to mixtures, pure substances, Avogadro's number, and the mole concept).

S8a2 Explains that each substance is characterized by a unique set of physical and chemical properties because it has a unique atomic composition and arrangement.

S8a3 Analyzes the relationship between the measurable properties of atoms (e.g., mass, volume, charge) and the properties of the smaller components of which atoms are composed (i.e., protons and neutrons in the nucleus, electrons in the electron cloud).

S8a4 Illustrates the structure of the atom, including the charge, relative mass, relative volume, and position within the atom of the electrons (in the electron cloud), and the protons and neutrons (which compose the nucleus).

S8a5 Recognizes the relationship between the charges on the nucleus and electrons, and the electric force that holds the atom together.

S8a6 Compares and contrasts isotopes of the same element (e.g., based on number of protons, neutrons, and electrons; atomic mass; electric charge; stability of the nucleus).

S8a7 Analyzes the relationship between the measurable properties of atoms (e.g., mass, volume, charge) and the properties of the smaller components of which atoms are composed (i.e., protons and neutrons in the nucleus, electrons in the electron cloud).

S8a8 Compares and contrasts isotopes of the same element (e.g., based on number of protons, neutrons, and electrons; atomic mass; electric charge; stability of the nucleus).

S8a9 Describes matter as being made of enormous numbers of minute particles called atoms (e.g., by referring to mixtures, pure substances, Avogadro's number, and the mole concept).

S8a10 Illustrates the structure of the atom, including the charge, relative mass, relative volume, and position within the atom of the electrons (in the electron cloud), and the protons and neutrons (which compose the nucleus).

S8a11 Recognizes the relationship between the charges on the nucleus and electrons, and the electric force that holds the atom together.

Chemistry

Standard: S8b: Analyzes and demonstrates the relationship between the structure and the properties of matter, focusing on chemical properties of elements and their placement in the Periodic Table.

Components:

S8b1 Distinguishes elements (i.e., substances composed of a single kind of atom) from compounds (i.e., substances composed of two or more kinds of atoms bonded together chemically).

S8b2 Predicts the placement of elements on the Periodic Table given physical and chemical properties, and vice versa (e.g., by referring to the atomic number, classes of elements, and repeating patterns of physical and chemical properties that identify families of elements with similar properties).

S8b3 Identifies, and explains the relationships between, trends in the properties of atoms on the Periodic Table (e.g., atomic number, number of valence electrons, ionization energy, electronegativity, relative sizes of atoms and ions).

S8b4 Analyzes the relationship between the chemical properties of an element, and the tendency of atoms of that element to interact with other atoms by transferring or sharing electrons that are furthest from the nucleus (e.g., using the octet rule and differences in electronegativity).

Chemistry Applications

Components:

S8b5 Predicts the placement of elements on the Periodic Table given physical and chemical properties, and vice versa (e.g., by referring to the atomic number, classes of elements, and repeating patterns of physical and chemical properties that identify families of elements with similar properties).

Chemistry

Standard: S8c: Analyzes and demonstrates the relationship between the structure and the properties of matter focusing on physical properties of molecular substances.

Components:

S8c1 Predicts that particles with opposite charges will attract (e.g., protons and electrons, positive and negative ions, molecules with partial but opposite charges), that particles with like charges will repel (e.g., protons in the nucleus, electrons in the electron clouds of atoms and molecules), and that the strength of the electric force between the particles increases in proportion to the charges but decreases with distance.

S8c2 Describes the factors that affect how simple molecules interact and form intermolecular bonds (e.g., constituent atoms, distances and angles between the atoms, charges and partial charges on the molecules).

S8c3 Explains physical properties of molecular substances (e.g., melting point, boiling point, density, viscosity, vapor pressure, solubility in different solvents) based on the nature of the interactions among those substances' molecules (e.g., tendency to form intermolecular attractions and crystalline structures).

S8c4 Compares and contrasts solids, liquids, and gases, based on the ability of molecules or atoms to move around or away from each other (i.e., based on average kinetic energy of the system, and the strength of attraction between molecules or atoms).

S8c5 Applies the kinetic molecular theory to explain the behavior of gases, and the relationship between pressure and volume, volume and temperature, pressure and temperature, and the number of particles in a gas sample.

S8c6 Compares and contrasts the properties of solutions and pure solvents (e.g., boiling point and melting point, vapor pressure, separate and combined volumes, ability to conduct electricity).

Chemistry Applications

Components:

S8c7 Applies the atomic-molecular theory to chemical reactions (e.g., balancing equations, calculating percent yield, identifying limiting reactants, determining percent composition).

S8c8 Applies the kinetic molecular theory to explain the behavior of gases, and the relationship between pressure and volume, volume and temperature, pressure and temperature, and the number of particles in a gas sample.

S8c9 Compares and contrasts the properties of solutions and pure solvents (e.g., boiling point and melting point, vapor pressure separate and combined volumes, ability to conduct electricity).

S8c10 Compares and contrasts solutions, suspensions, and colloids, using knowledge of intermolecular forces.

S8c11 Compares and contrasts water and other substances in their solid, liquid, and gaseous states, based on the ability of molecules or atoms to

move around or away from each other (i.e., based on average kinetic energy of the system, and the strength of attraction between molecules or atoms).

S8c12 Describes the factors that affect how simple molecules interact and form intermolecular bonds (e.g., constituent atoms, distances and angles between the atoms, charges and partial charges on the molecules).

S8c13 Describes the process (for petroleum, as an example) of fractional distillation and names the products from each fraction.

S8c14 Distinguishes between chemical and physical properties and/or changes.

S8c15 Distinguishes between chemical and physical properties and/or changes.

S8c16 Explains physical properties of molecular substances (e.g., food matter) as based on the nature of the interactions among those substances' molecules (e.g., carbohydrates and fats).

S8c17 Explains physical properties of water, petroleum, and other molecular substances (e.g., melting point, boiling point, density, viscosity, vapor pressure, solubility in different solvents) based on the nature of the interactions among those substances' molecules (e.g., tendency to form intermolecular attractions and crystalline structures) and the implications of these properties for transformations in manufacturing.

S8c18 Identifies the chemical and physical processes of conserving renewable and nonrenewable resources.

S8c19 Identifies the chemical and physical processes of conserving renewable and nonrenewable resources.

S8c20 Predicts that particles (such as those in water) with opposite charges will attract (e.g., protons and electrons, positive and negative ions, molecules with partial but opposite charges), those with like charges will repel (e.g., protons in the nucleus, electrons in the electron clouds of atoms and molecules), and that the strength of the electric force between the particles increases in proportion to the charges but decreases with distance.

S8c21 Describes the process (for petroleum, as an example) of fractional distillation and names the products from each fraction.

Chemistry

Standard: S8d: Assesses interactions of matter focusing on chemical reactions and bonds.

Components:

S8d1 Explains chemical bonding (e.g., covalent, polar-covalent, ionic) as the pairing of electrons via transfer or sharing between atoms, resulting in distinct molecules or repeating three-dimensional crystalline arrangements of atoms.

S8d2 Applies the atomic-molecular theory to chemical reactions (e.g., balancing equations, calculating percent yield, identifying limiting reactants, determining percent composition).

S8d3 Categorizes chemical reactions into one of five basic types (i.e., synthesis, decomposition, single replacement, double replacement, combustion) based on chemical equations and experimental observations.

S8d4 Compares and contrasts reactions that involve the transfer of electrons (i.e., oxidation/reduction reactions) or hydrogen ions (i.e., acid/base reactions) between reacting ions, molecules, or atoms.

S8d5 Explains the role of highly reactive radicals in chemical chain reactions (e.g., the presence of ozone and greenhouse gases in the atmosphere, the burning and processing of fossil fuels, the formation of polymers, and explosions).

S8d6 Explains why such an enormous variety of substances (e.g., synthetic polymers, oils, the large molecules essential to life) can be formed from a backbone of carbon atoms (i.e., because carbon atoms can form four bonds, including single, double, and triple bonds, and bond to each other to form chains, rings, and branching networks).

S8d7 Explains why such an enormous variety of substances (e.g., synthetic polymers, oils, the large molecules essential to life) can be formed from a backbone of carbon atoms (i.e., because carbon atoms can form four bonds, including single, double, and triple bonds, and bond to each other to form chains, rings, and branching networks).

S8d8 Provides examples of and describes chemical reactions that occur in everyday life (e.g., in health care, cooking, cosmetics, automobiles, and in our bodies).

Chemistry Applications

Components:

S8d8 Applies the atomic-molecular theory to chemical reactions (e.g., balancing equations, calculating percent yield, identifying limiting reactants, determining percent composition).

S8d9 Compares and contrasts reactions that involve the transfer of electrons (i.e., oxidation/reduction reactions) or hydrogen ions (i.e., acid/base reactions) between reacting ions, molecules, or atoms

S8d10 Compares saturated/unsaturated hydrocarbons (models, formulas, structures, properties).

S8d11 Describes chemically the transformations of elements (e.g., nitrogen) and molecules (e.g., water) through the environment (e.g., water and nitrogen cycles).

S8d12 Explains the role of highly reactive radicals in chemical chain reactions (e.g., the presence of ozone and greenhouse gases in the atmosphere, the burning and processing of fossil fuels, the formation of polymers, the extraction of minerals from ores, and explosions.)

S8d13 Explains why such an enormous variety of substances (e.g., synthetic polymers, oils, the large molecules essential to life) can be formed from a backbone of carbon atoms (i.e., because carbon atoms can form four bonds, including single, double, and triple bonds, and bond to each other to form chains, rings, and branching networks).

S8d14 Provides examples of and describes chemical reactions that occur in everyday life (e.g., in health care, cooking, cosmetics, automobiles, and in our bodies).

Chemistry

Standard: S8e: Analyzes variables that govern the rates of chemical and physical change.

Components:

S8e1 Compares and contrasts physical and chemical change (e.g., based on bond strength, reversibility, applicability of conservation laws), explaining both as changes in the arrangement and motion of atoms and molecules

S8e2 Describes the enormous range of time periods over which chemical reactions can take place (i.e., from a few seconds to billions of years).

S8e3 Describes factors that can change the rate of dissolving (e.g., concentration, pressure, temperature, mixing, particle size and shape, surface area).

S8e4 Investigates and explains the effect of factors that can change the rate of chemical reactions (e.g., concentration, pressure, temperature, mixing, particle size and shape, surface area).

S8e5 Compares and contrasts catalysis by metal surfaces and by enzymes.

S8e6 Investigates and describes equilibrium systems (e.g., buffers, indicators, and other chemical systems) and factors that can cause a shift in the equilibrium of a system (e.g., concentration, pressure, volume, temperature).

Chemistry Applications

Components:

S8e7 Compares and contrasts catalysis by metal surfaces and by enzymes (such as the effect of proteins on cellular reactions).

S8e8 Describes factors that can change the rate of dissolving (e.g., concentration, pressure, temperature, mixing, particle size and shape, surface area).

S8e9 Investigates and explains the effect of factors that can change the rate of chemical reactions (e.g., concentration, pressure, temperature, mixing, particle size and shape, surface area).

Chemistry

Standard: S8f Explains and illustrates the conservation of energy.

Components:

S8f1 Explains that energy can be transferred (e.g., by collisions and radiations) but never destroyed.

S8f2 Provides examples of kinetic energy (e.g., electrical, radiant, thermal) being transformed into potential energy (e.g., chemical) and vice versa (e.g., during chemical reactions, changes of state, and the formation of solutions).

S8f3 Explains that energy tends to spread out uniformly (e.g., from hotter to cooler objects) unless hindered (e.g., by insulation, or by high-energy intermediates in some chemical reactions).

S8f4 Provides examples of energy being released by or initiating chemical reactions (e.g., burning fossil fuels, photosynthesis, the evolution of urban smog).

S8f5 Predicts whether energy will be released or absorbed during a chemical or physical change (e.g., chemical reaction, change of state, formation of a solution), given the configuration of atoms and molecules and their associated energy levels.

S8f6 Predicts and explains the ability of electric energy to flow readily through some materials (e.g., metals, ionic solutions) but not others (i.e., relating conductivity to the ability of charged particles to flow through the material).

S8f7 Distinguishes between temperature and heat.

S8f8 Explains that each kind of atom or molecule can gain or lose energy only in particular discrete amounts.

Chemistry Applications

Components:

S8f9 Describes major sources of energy and alternative sources of fuels and builder molecules.

S8f10 Explains that energy can be transferred (e.g., by collisions and radiation) but never destroyed.

S8f11 Explains that light can initiate reactions such as photosynthesis and the evolution of urban smog.

S8f12 Provides examples of kinetic energy (electrical, radiant, thermal) being transformed into potential energy (e.g., chemical) and vice versa (e.g., during chemical reactions, changes of state, and the formation of solutions).

S8f13 Distinguishes the split (fission) of certain nuclei into small nuclei and several neutrons from the combination (fusion) of two small nuclei into a more massive, given high temperature and pressure.

S8f14 Provides examples of energy being released by or initiating chemical reactions (e.g., burning petroleum and other fossil fuels, photosynthesis, the evolution of urban smog).

S8f15 Predicts whether energy will be released or absorbed during a chemical or physical change (e.g., chemical reaction, change of state, formation of a solution), given the configuration of atoms and molecules and their associated energy levels.

S8f16 Predicts and explains the ability of electrical energy to flow readily through some materials (e.g., metals, ionic solutions) but not others (i.e., relating conductivity to the ability of charged particles to flow through the material).